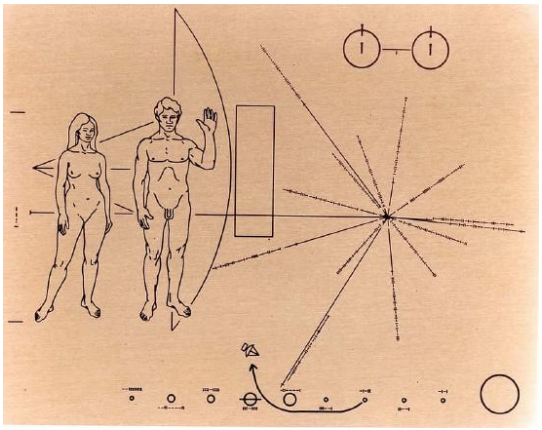
7.8: Missions to the Outer Solar System

7.8.1 Pioneer and Voyager

Because of the difficulty and expense involved, we have not sent as many missions to study the Jovian planets and their moons. NASA launched Pioneer 10 in March of 1972 and it became the first probe to cross the asteroid belt. On November 6, 1973, Pioneer 10 began taking pictures of Jupiter. After its flyby of Jupiter, it continued out to head out to the edge of the solar system, studying the solar wind and cosmic rays. We lost radio contact on January 23, 2003.

Following its policy of duel missions, NASA launched Pioneer 11 on April 6, 1973. Like its twin, Pioneer 11 studied the asteroid belt, Jupiter, cosmic rays, and the solar wind. It also became the first probe to study Saturn and its rings in a flyby. Like Pioneer 10, Pioneer II is now on course to leave the solar system. NASA reported its last radio contact with Pioneer 11 November 24, 1995.

Both Pioneer 10 and 11 carried a gold plaque showing our relative position, a hydrogen molecule, and images of a man and a woman. Though it will be many thousands of years before either Pioneer probe passes near another star, the hope was that this message of piece might one day be found by an alien civilization.



Both Pioneer probes carried this plaque as a message to any future alien civilization.

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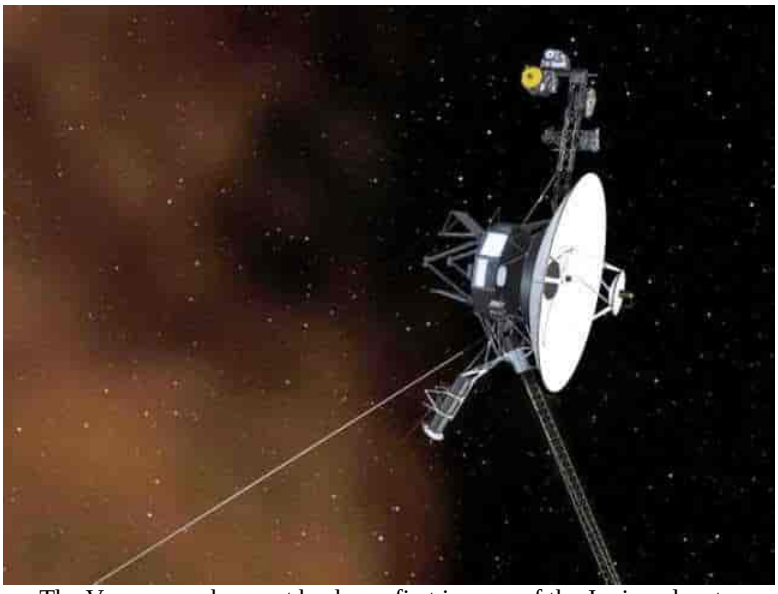
NASA decided to build on the success of Pioneer 10 and 11 by taking advantage of a once in a lifetime alignment of the Jovian planets with would enable them to send a probe to all four of them. Such an alignment only occurs every 160 years and NASA was determined not to miss it. Redesigning the Pioneer probes, NASA created the two Voyager probes. NASA launched Voyager 1 on September 5, 1977 and Voyager 2 on August 20, 1977. Even though they launched Voyager 2 first, NASA sent Voyage 1 on a faster trajectory so that it reached Jupiter first. Voyager 1 conducted flybys of Jupiter, Saturn, and Saturn's moon Titan. Voyager 1 discovered three new moons of Jupiter, which were named Adrastea, Metis, and Thebe. It also discovered active volcanoes on Jupiter's moon Io and that Europa's ice crust is "cracked" due to tidal heating and may have a liquid water interior. After its flyby of Saturn, Voyager 1 headed "north" in the solar system. On August 25, 2012, Voyager 1 became the first satellite to reach **heliopause**, the boundary between the Sun's magnetosphere and the magnetosphere of the Milky Way Galaxy. This made it the first probe to enter what many astronomers consider interstellar space, although it will be many more years before it reaches the Oort Cloud of comets that surround our Solar System.

Voyager 2 made flybys of Jupiter, Saturn, Uranus, and Neptune and to date, is the only probe to visit Uranus and Neptune. Voyager 2 transmitted high-resolution photos of Europa, confirming the findings of Voyager 1. Like Voyage 1, Voyager 2 has also reached heliopause and is traveling through interstellar space. Just as the Pioneer probes carried a gold plate as a message to any alien civilization, both Voyager 1 and Voyager 2 carried a golden record that included sounds of Earth, including greetings in various languages and music from Mozart and Chuck Berry. Both Voyager probes continue to transmit data and their radioactive power supplies are expected to run out sometime in 2024-2025.



The Voyager probes sent back our first images of the Jovian planets.

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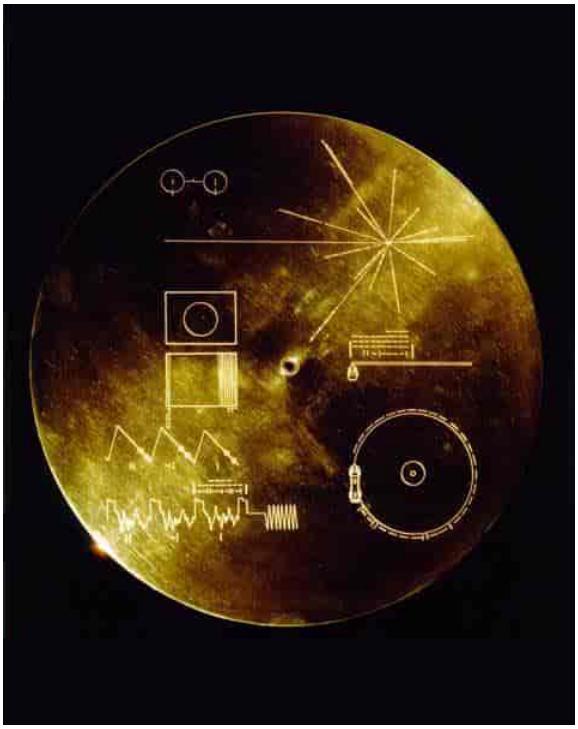

Both of the Voyager probes carried a gold record with recordings of music and greetings from Earth.

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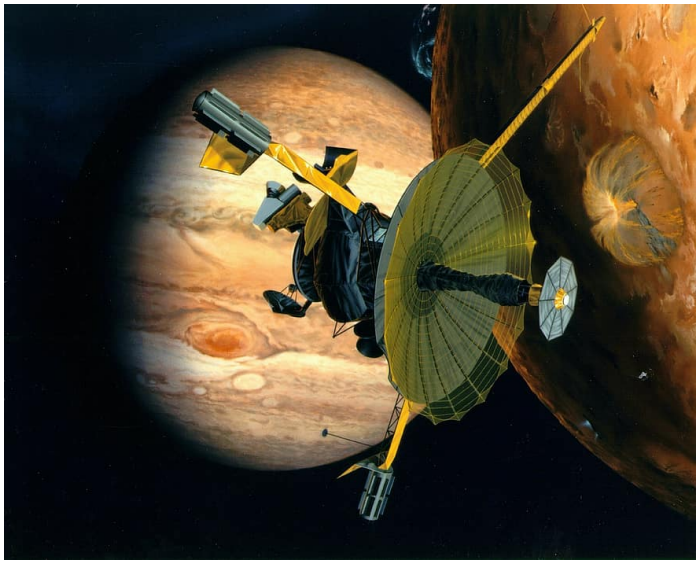
7.8.2 Ulysses and Galileo

In 1990, NASA and ESA launched Ulysses, a join mission to study the Sun. In February 1992, it made a gravity assist maneuver with Jupiter to fly above the orbital plane of the solar system. As Ulysses flew over Jupiter's north pole and made measurements of its magnetic field.

In October 1988, NASA launched Galileo by the Atlantis shuttle. NASA had planned to launch Galileo earlier, but the Challenger disaster delayed several missions, including Galileo. This proved to be a problem as when scientists attempted to open its high gain antenna, it failed to deploy. Apparently, while Galileo had been in storage waiting for its rescheduled launch, the lubricant for its antenna had degraded and failed to work. After several attempts to open the high gain antenna failed, NASA had to resort to send all of Galileo's data through its low gain antenna. The low gain antenna was designed only for maneuvering and course corrections and could not handle all the data planned for Galileo. However, through compression techniques and other efforts, NASA was able to salvage much of Galileo's mission.

As it passed through the Asteroid Belt, Galileo, made a flyby of the asteroid Gaspra and discovered the first asteroid moon. Galileo also captured images of the comet Shoemaker-Levy-9's crash into Jupiter's atmosphere in 1994. Then, it reached Jupiter on December 7, 1995. In July 1995, it dropped a probe into Jupiter's atmosphere which collected data for 57 minutes. Galileo also found more evidence that Europa has liquid water under its surface and found that Ganymede has a strong magnetic field, making it unique among moons. In September 2003, NASA allowed Galileo to burn up in Jupiter's atmosphere to prevent its moons from being contaminated with Earth bacteria.



The Galileo probe dropped the first atmospheric probe into one of the Jovian planets, Jupiter.

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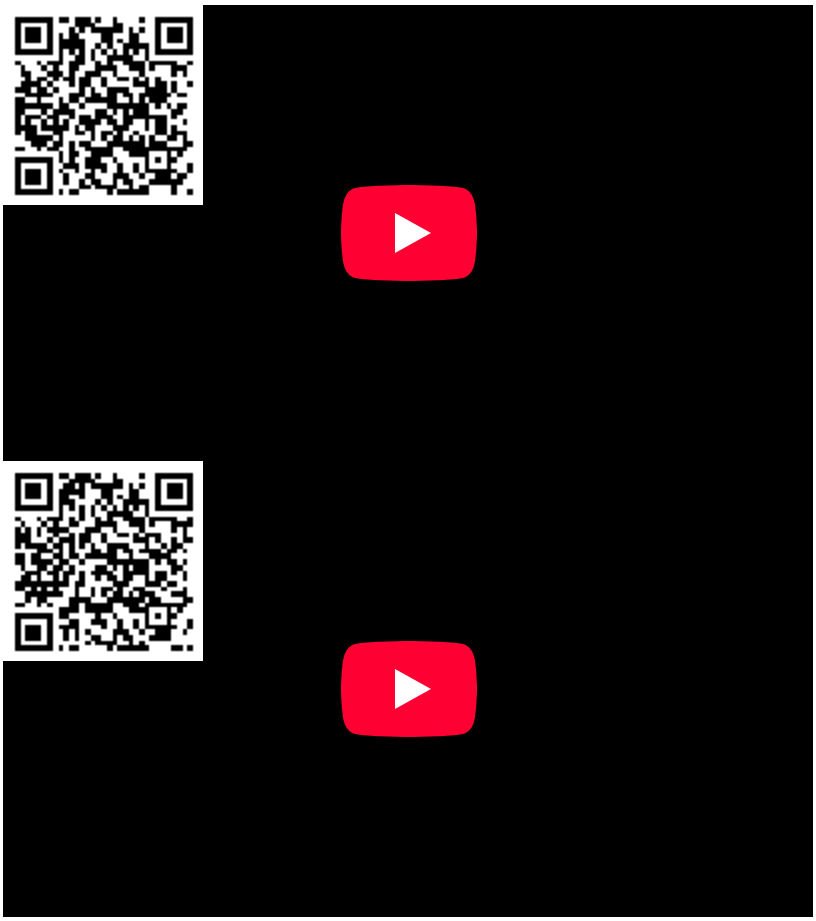
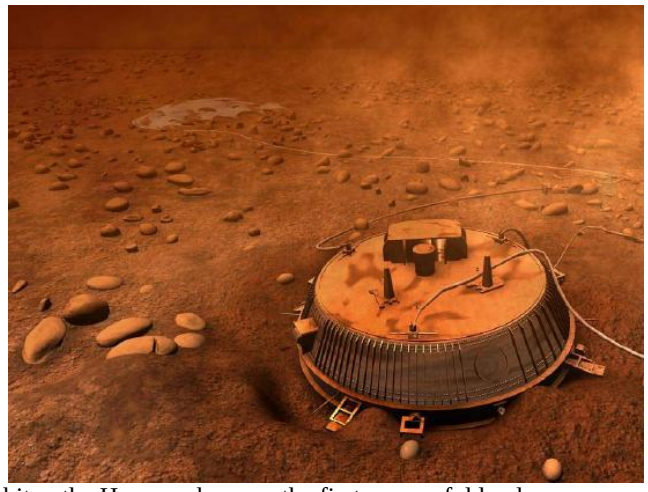


7.8.3 Cassini-Huygens

The next mission to the outer solar system was another joint NASA-ESA mission. Cassini-Huygens was launched on October 15, 1997. This mission consisted of two components the Cassini orbiter and the Huygens lander. It made a flyby of Jupiter on March 5, 2003 and made detailed study of Jupiter's atmosphere, the Great Red Spot, and Jupiter's rings. Its primary target, though, was Saturn and on January 14, 2005, the Huygens module parachuted into Titan's atmosphere and transmitted data for 90 minutes, making it the first successful landing on a moon other than Earth's and first landing in the outer solar system. Cassini made important discoveries about Saturn's rings and moons while Huygens gave us our first glimpse of the atmosphere and surface of Titan. In September 2017, NASA allowed Cassini to enter Saturn's atmosphere and burned up.



Released by the Cassini orbiter, the Huygens became the first successful lander on a moon in the outer solar system.

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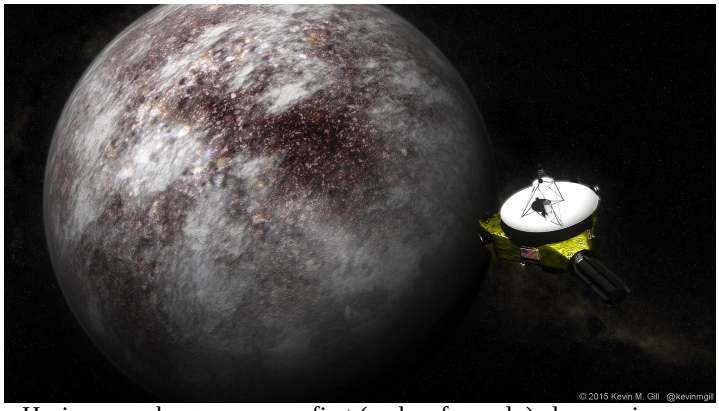
7.8.4 Juno

On August 5, 2011 by NASA launched Juno, which entered a polar orbit of Jupiter on July 5, 2016.

The spacecraft is studying the planet's composition, gravity field, magnetic field, and polar magnetosphere and is looking for evidence that Jupiter has a rocky core. Juno’s mission was originally scheduled to end on July 30, 2021, where, like its predecessor Galileo, it would burn up in Jupiter’s atmosphere. However, NASA has extended its mission until 2025.

7.8.5 New Horizons

Finally, NASA launched New Horizons on January 19, 2006. On February 28, 2007 it made a flyby gravity assist around Jupiter. Then, on January 15, 2015, the spacecraft began its approach phase to Pluto. In August 2016, New Horizons was reported to have traveled at speeds of more than 84,000 km/h (52,000 mph). On October 25, 2016, at 21:48 UTC, the last of the recorded data from the Pluto flyby was received from New Horizons. Having completed its flyby of Pluto, New Horizons then maneuvered for a flyby of Kuiper belt object 486958 Arrokoth (then nicknamed Ultima Thule), which occurred on January 1, 2019. It is now the fifth man-made object to reach escape velocity of the Solar System after Pioneers 10 and 11 and Voyagers 1 and 2.



The New Horizons probe gave us our first (and so far, only) close up images of Pluto.

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